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Press

Institute of Sport Sciences and Physiotherapy, Faculty of Medicine, University of Tartu, Estonia

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In paper I, II and III Kerli Mooses had primary responsibility for protocol development, data collection, cleaning, analysis and interpretation, and writing manuscripts.

INTRODUCTION

There is abundance of evidence concerning the positive influence of moderate to vigorous physical activity (MVPA) [1–3] and independent negative influence of sedentary time on physical and mental health [4]. In order to gain positive health benefits, it is recommended that children and youth aged 5–17 should accumulate a minimum of 60 minutes of MVPA every day [5]. However, the physical activity levels of students remain low in several developed countries [6], thus posing a serious public health risk.

Students acquire MVPA throughout the school day, thus each day segment should offer opportunities for students to be engaged in physical activity. However, it is unclear to what extent the physical activity of students compliant and non-compliant with physical activity recommendations differ during the same day segment. It has been stressed that in order to combat the decreasing physical activity and increasing sedentary time a multilevel and cross-sectoral co-operation is needed [7]. The school has been targeted as an influential setting with the potential to ensure healthy physical activity levels for all students [8], as students with different socio-economic background can be reached. According to studies, in-school physical activity significantly contributes to daily MVPA and more than a third of whole day MVPA can be acquired at school [9–11], thus highlighting the critical role of school in the maintenance of the recommended levels of physical activity. In school setting, the physical education lesson and class time are identified as two school day segments where low active students may benefit the most from physical activity interventions [12]. However, little research has been published concerning the physical activity and sedentary time in different academic lessons, and the differences in levels of physical activity between school stages. As for physical education lesson, its role in supporting the physical activity levels of students and teaching skills necessary for lifelong physical activity is highly recognised. At the same time, there is no consensus whether students compensate higher physical activity in physical education lesson by lowering physical activity afterwards.

Interventions aimed at increasing the physical activity and decreasing sedentary time need to ensure cultural sensitivity and adapt strategies to accommodate varying local realities [13]. Therefore, while planning and implementing interventions, it is essential to know the current situation in details. Unfortunately, to date there has been no research on physical activity and sedentary time in different school day segments and school stages in Estonia. Therefore, the main aim of the study was to assess the objectively measured physical activity and sedentary time in different lessons, and the students' compliance with physical activity recommendations on school days.

1. LITERATURE REVIEW

1.1. The associations between health outcomes, physical activity and sedentary behaviour in children

Physical activity is defined as “any bodily movement produced by skeletal muscles that requires energy expenditure and produces progressive health benefits”[14]. There is an ample of evidence supporting the favourable relationship between physical activity and health in children [2,3]. Previous research has established the beneficial effects of physical activity on adiposity [1–3], musculoskeletal health [1–3], several cardio-metabolic risk factors [1–3,15,16] and physical fitness [1,2]. In addition, a growing body of literature highlights the importance of physical activity and physical fitness on cognition [17,18], on-task behaviour [19–22], academic achievement [1,18,23–26] and mental health [1,2]. A recent review concluded that any physical activity, despite the consecutive duration, has positive influence on health and physical activity can be accrued in small doses throughout the day [2]. At the same time, there is also a dose-response relationship, showing that more physical activity, both in terms of intensity and amount, is associated with greater health benefits [2,3]. According to World Health Organisation (WHO), children and youth aged 5–17 should accumulate a minimum of 60 minutes of MVPA every day in order to gain necessary health benefits [1,5]. These recommendations have been adapted by several countries [27], including Estonia [28]. At the same time, there are countries where the minimum amount of recommended daily physical activity is higher than 60 minutes for children aged 0–5 years [27]. For example, in Finland (a minimum of 2 hours per day) [27], UK and Australia (a minimum of 3 hours per day) [27,29]. Still, to the best of our knowledge Germany is the only country that has issued recommendations that are more demanding than those released by WHO for children aged 5–17, suggesting a minimum of 90 minutes of physical activity every day [30].

More recently, sedentary time has been identified as an independent health risk factor in children and youth [4,16,31–33]. Sedentary behaviour is any waking behaviour characterised by an energy expenditure ≤1.5 metabolic equivalents (METs) while in sitting or reclining posture [34]. Excessive sedentary time has been associated with unfavourable body composition [4,31], decreased fitness, lower self-esteem, lower pro-social behaviour [4] and increased risk of cardiovascular disease [4,16]. Although, interruptions in sedentary time are associated with improvements in various metabolic variables in adults [35], there is little research on whether the patterns of sedentary behaviour have impact on health outcomes of children. Some studies have found associations between breaks in sedentary time and short 1–4 minute bouts of sedentary time with reduced cardio-metabolic risk independent of total sedentary time and physical activity [36,37], while no such association has been observed for longer sedentary bouts in large sample of children [37,38]. As for obese/overweight children, both total volume and prolonged (>30 minute) sedentary bouts have been associated with lower HDL cholesterol levels [39]. Based on current findings, it is advised to break up sitting as frequently as possible and avoid prolonged sitting [4,33].

1.2. The overall physical activity levels of children and youth

Low physical activity levels of children are a growing public health concern worldwide. Numerous studies have shown a low prevalence of children being compliant with physical activity recommendations in many developed countries [6,40,41]. While research with self-reported data indicate that 14–40% of children and youth are sufficiently active [41,42], studies with objectively measured physical activity data (and using Evenson cut-off points [43]) suggest that the prevalence of children compliant with physical activity recommendation ranges from 20% in Spain to 87% in Norway [6]. In Estonia, according to a study of Health Behaviour of School-Aged Children (HBSC) conducted in 2013/2014 only 16% of 11–15 year-old students meet the physical activity recommendations every day [44]. Based on physical activity data from HBSC study in 2010, Estonia ranked 25th out of 32 countries involved in a survey [41]. There is little data available concerning the objectively measured physical activity of Estonian school-aged children. In a study conducted in two decades ago, approximately 65% of 9–15 year-old students met the physical activity recommendations on weekdays and approximately 50% on weekend days [45]. However, more recent study with 2–10 year-old children showed that 13% of girls and 27% of boys were compliant with physical activity recommendations [40].

Therefore, as physical activity plays a critical role in the maintenance of children health [2,3] and a great proportion of children do not meet the physical activity recommendations [6], there is an urgent need to address the pandemic of physical inactivity [46]. Based on socio-ecologic model [47], being physically active is not only the decision of an individual, but it is influenced by social and community networks (e.g. relationships), and general socio-economic, cultural and environmental conditions (e.g. access to sport facilities, built environment, legislation etc.). Thus, it has been stressed that in order to increase the physical activity levels, multilevel and multisectoral plans are needed and all sectors outside health sector must be involved [7,13]. The importance of educational system has been emphasised in many international documents [8], including the Toronto Charter for Physical Activity [13], and whole-school approach has been identified as one of the seven best investments in increasing the physical activity and reducing the sedentary time of children [48]. An advantage of school setting is the possibility to influence the physical activity of students with different socio-economic background and lifestyle habits. Therefore, schools have the potential to become the central element in the community that ensure healthy physical activity levels for all students [8]. According to a Cochrane review physical activity should be promoted throughout the school during all lessons and recess [49], while the Comprehensive School Physical Activity Programs (CSPAP) in USA organize physical activity opportunities around five points of intervention 1) physical education lesson, 2) staff involvement, 3) physical activity during school, 4) physical activity before and after school, 5) family and community engagement [50].

1.3. Physical activity and sedentary behaviour in school

Students spend a lot of their time at school, therefore it has been suggested by American Heart Association that a minimum of 30 minutes of MVPA should be acquired at school [8], which is half of the daily recommendation. Still, several studies show that the physical activity in school remains below this 30 minute recommendation [10,12,51,52]. For example, in five European countries, the proportion of students acquiring a minimum of 30 minutes of MVPA during school hours ranged from 2–14% depending on the country, showing an average of 7% [51]. Moreover, the amount of physical activity acquired in school is reduced with age [9,53–55]. A study with students from 1st to 6th grade demonstrated that the odds of meeting 30-minute recommendation in school was 26% lower in older grades compared to younger grades [55] and students younger than 9 years accumulated 4 more minutes of in-school MVPA compared to 9-year-old and older students [53]. Therefore, several school-based interventions have been implemented in different countries aimed at increasing the levels of physical activity. The results of interventions where physical activity was incorporated to lessons and/or recess have shown an increase in the proportion of students acquiring 30 minutes of MVPA in school – approximately 36% of students met the 30-minute recommendation after intervention [21,53]. Also, approximately a 25-minute contribution of in-school MVPA to daily MVPA has been reported by others [10]. The importance of in-school physical activity is highlighted by the fact that students can acquire 30–45% of whole day MVPA in school [9–11]. Moreover, higher in-school MVPA has been associated with an increase in daily MVPA minutes [11]. However, to the best of our knowledge, there has been only one detailed investigation exploring the extent in the variation of MVPA between students with different overall physical activity levels [52]. This study by Fairclough et al [52] concluded that high active students, who achieved physical activity recommendation on ≥50% of their valid days, acquired more MVPA minutes both in school and out of school compared to students classified as low active. Whether such differences between compliant and non-compliant students with physical activity recommendations are present in other populations warrants further investigation.

Considering the in-school time, physical education lesson and class time are identified as two school day segments where low active students may benefit the most from physical activity interventions [12]. One reason why lesson time is an important setting to be addressed in school is the fact that the majority of school time is spent in lessons. Moreover, according to a recent review, using physically active methods for teaching academic content may improve MVPA levels, BMI and academic performance of students [56]. At the same time the traditional teaching seems to dominate in lessons as more than 70% of lesson time is spent as sedentary [57–59], whereas the proportion of MVPA remains as low as 1% [57]. Several interventions have managed to increase lesson time physical activity so that up to 13% of lesson time is spent in MVPA [58,59]. Subject-specific interventions (e.g. interventions in mathematics or native language lessons) where physical activity was integrated with lesson context have shown that more than 60% of lesson time is spent in MVPA [60,61]. Previous research [57–59] has mainly concentrated on physical activity in overall lesson time. Therefore, there has been little quantitative analysis on the physical activity levels in different subjects. Moreover, to date far too little attention has been paid on the sedentary behaviour during lessons and on the differences in physical activity and sedentary behaviour between different school stages.

Existing research recognises the critical role played by physical education lesson in supporting the physical activity levels of students, as on days with physical education lesson, students accumulate more MVPA minutes compared to days without physical education lesson [12,62–64]. In addition, there is a considerable amount of literature available concerning the time spent in MVPA during physical education lessons [64–66]. Although it has been advised by American Heart Association that students should spend at least 50% of the physical education lesson in MVPA [8], previous reviews and meta-analysis indicate that in reality students spend 27% to 47% of physical education lesson in MVPA [67–69], regardless of the measurement instrument. At the same time data about the sedentary time during physical education lessons are limited to few authors who have reported the proportion of sedentary time forming 16% to 23% of total lesson time [64,70,71]. In addition, there is no consensus on whether the amount of sedentary time on days with and without physical education lesson is different [62,64,70,72].

When considering the contribution of physical education lesson, a number of studies have confirmed its significance, as 10–17% of daily MVPA is acquired in physical education lesson [62,70]. Despite this, there is an ongoing debate whether students compensate for higher in-school activity after school [11,73]. According to “activitystat” hypothesis an increased physical activity in one part of the day results in a decrease in physical activity in another part of the day in order to maintain overall stable level of physical activity [74,75]. So far the results of studies testing this hypotheses are inconclusive in all age groups studied [75]. This “activitystat” hypothesis has little been studied in the context of physical education lesson. Some studies have indicated that participation in physical education lesson leads to a significantly higher overall daily MVPA [12,62,64,70] and an higher proportion of students achieving daily physical activity recommendations [64], while others have not documented such associations [73].

In order to increase the physical activity and decrease sedentary time, the guiding principles of Toronto Charter stress the need to ensure cultural sensitivity and adapt strategies to accommodate varying local realities and contexts [13]. Therefore, the prerequisite of effective interventions, is knowing the current situation in details. To date, there has been no research on the physical activity and sedentary time in different in-school segments in Estonia. This dissertation seeks to obtain data which will help to address this research gap, thereby providing an exciting opportunity to advance our knowledge both nationally and internationally on physical activity and sedentary time in school setting and in addition, give an important indication for the need of physical activity intervention.

2. THE AIM OF THE STUDY

The main aim of the study was to assess objectively measured physical activity and sedentary behaviour of 7–13 year-old students in different lessons and compliance with physical activity recommendations on school days.

More specifically, the aims were:

1. To investigate the objectively measured moderate to vigorous physical activity of students and their compliance with physical activity recommendations on school days.
2. To examine the moderate to vigorous physical activity and sedentary time of students in academic lessons by school stage.
3. To investigate differences in moderate to vigorous physical activity and sedentary time of students during physical education lesson by gender and school stage.
4. To determine the contributing role of physical education on daily moderate to vigorous physical activity and sedentary time.

3. METHODS

3.1. Participants and setting

A database with records of Estonian-speaking comprehensive schools in Estonia was acquired from the Ministry of Education and Research. From the database schools across Estonia were randomly selected, with the criterion that no more than two schools from the same county were chosen. Special schools for students with mental and/or physical disability were excluded from the sample. The sample of schools asked to participate in the study varied according to school ownership (private vs municipality schools), school location (city vs countryside) and size (63 vs 685 students). Out of all schools invited, two schools refused to participate in the study. Written informed consent was received from all schools, parents and students participating in the study. From all consented students (n = 819, participation rate 57%) a randomly selected subsample of 636 students was formed for measuring physical activity and anthropometry so that all consented schools and classes were represented. A subsample was formed due to the limited number of accelerometers available for study period. Students measured attended 1st or 2nd grade (first school stage, n = 352) or 4th or 5th grade (second school stage, n = 284). The final sample consisted of 13 schools, students from 84 classes and covered 60% of Estonian counties. In most schools the lessons lasted for 45 minutes, followed by 10–15 minutes long break. Only in two schools the duration of physical education lesson was 90 minutes in second school stage.

The study was in accordance with the Declaration of Helsinki and approved by Research Ethics Committee of the University of Tartu (nr 242/T-17).

3.2. Instrumentation and procedure

The physical activity was measured for one school week from December 2014 to May 2015 using accelerometer Actigraph GT3x-BT (ActiGraph LLC, Penascola, FL, USA) with 15-s epochs. Winter and spring months were included to the study period in order to describe the overall levels of physical activity despite the season. On the first measurement day, students were instructed to wear the accelerometer on the hip for seven consecutive days, to remove accelerometer for water-based activities (e.g. showering, swimming etc.) and to retain their usual activity. For the purpose of current analysis, only days when students attended the school were included. In addition, students were asked to fill accelerometer diary every day and write down the beginning and end times for sleep, school, physical education lesson, organised sport sessions. The parents were asked to help their child with filling the diary if necessary. To minimize potential differences between the actual and students' reported school hours, exact timetables for measurement period were obtained from schools.

Additionally, selected demographic (gender, age) and anthropometric (height, body mass) measures were recorded on the first measurement day by trained researcher. Height (Seca 213, Seca GmbH, Hamburg, Germany) and body mass (A&D Instruments, Abington, UK) were measured to the nearest 0.1 cm and 0.1 kg respectively and body mass index (BMI) was calculated. The International Obesity Task Force age-specific BMI cut-off points were used to classify students as underweight and normal or overweight and obese [76].

Physical activity data was downloaded from accelerometers and processed using ActiLife software version 6.11.2 (ActiGraph LLC, Penascola, FL, USA). To calculate minutes spent in sedentary (≤100 counts per minute), light (101–2295 counts per minute) and MVPA (≥2296 counts per minute) Evenson cut-points were used [43], as they have shown the best classification accuracy in children [77]. In the analysis of academic lessons, sedentary bouts were also observed. A sedentary bout was defined as a time when counts per minute were below 100. The bout stopped when the accelerometer counts per minute were ≥ 100 for three minutes [36]. An average bout length for each participant in each lesson was calculated.

Data inclusion criteria varied depending on the research question (table 1). In order to describe physical activity of students compliant and non-compliant with physical activity recommendations on school days, at least 10 hours of recorded data per day with a minimum of four valid school days was needed. In order to determine the contributing role of physical education to daily MVPA and sedentary time, the inclusion criteria was at least 10 hours of recorded data per day with a minimum of three valid school days present [78]. For both research questions zero counts of 20 consecutive minutes were classified as non-wear time [51,52]. As for analysis of physical education lessons, all included students had at least one day with and one day without physical education lesson. In order to analyse different academic lessons, a minimum of 240 minutes of wear time was needed and consecutive zero counts for 60 minutes were classified as non-wear time to retain comparability with previous studies in this domain [21], also the data of first measurement day was excluded in order to eliminate potential bias caused by the distribution of accelerometers and performing anthropometric measurements during lessons. In order to include academic or physical education lesson into the analysis, a minimum of 40 minutes of accelerometer data per lesson was required. In all analysis, the included and excluded students were similar in terms of gender, BMI and school level ($p > 0.05$).

Table 1. Minimum hours and number of valid days of accelerometer data and non-wear time by research question

	Minimum hours of physical activity data per day	Minimum number of valid days	Minimum duration of consecutive zero counts (non-wear time)
Compliance with physical activity recommendations	10h	4	20 min
Academic lessons	4h	1	60 min
Physical education lessons	10h	3	20 min

In order to obtain the physical activity data for different day segments (e.g. before school, in-school, after school) and for different subjects, time filters, which were based on the information from school time tables and diaries filled by students, were applied. Lessons classified as academic in the analysis were native language (Estonian), mathematics, science, foreign language, music and crafts/arts (hereinafter crafts) as these lessons are taught throughout first and second school stage. Students were considered compliant with the physical activity recommendations when they had 60 or more MVPA minutes for at least four measured days [79]. The prevalence of students acquiring 30 minutes of MVPA in school and the prevalence of students engaged in MVPA for 50% of physical education lesson [8] were calculated.

3.3. Statistical analysis

For descriptive statistics means and standard deviations were calculated. To explore the differences between compliant and non-compliant students or school stages, depending on the nature of the variables chi-square test, t-test or Mann-Whitney U test was used. The level of significance was set at <0.05.

In order to take into account the nested structure and the repeated nature of the data linear mixed models were used to explore differences in physical activity [80]. To analyse physical activity on school days and in physical education lessons, three level models were used, where level I comprised days when students attended the school, level II students and level III schools. When analysing physical activity in academic lessons, student level was replaced with class level, as in class setting students have more constraints to make decisions concerning physical activity and their behaviour is more dependent on the decisions of the teacher compared to other school day segments. All models were adjusted for gender, school stage and BMI. To explore differences between compliant and non-complaint students in different school day segments, models were separately run for MVPA as dependent variable for each day segment and were additionally controlled for time spent in the segment investigated. When physical activity and sedentary behaviour was analysed in academic lessons, models were separately run for sedentary time, MVPA and average sedentary bout length as dependent variable for each subject. In the analysis of physical education lessons and its contribution to daily MVPA, different linear mixed models for MVPA and sedentary time were run which were additionally controlled for participation in organised sport and time spent in physical education lesson. To determine the differences between days with and without physical education lesson, models for MVPA and sedentary time were additionally controlled for the participation in physical education lesson and in organised sport.

The statistical significance of the model estimates was evaluated using 95% confidence intervals (95% CI). Data was analysed with the statistical program R version 3.0.2, for linear mixed models the package lme4 was used [81,82].

4. RESULTS

4.1. Moderate to vigorous physical activity on school days and compliance with physical activity recommendations

Students included into the analysis of school day MVPA are described in table 2. On average girls acquired 65.8 ± 33.8 and boys 73.1 ± 35.1 minutes of daily MVPA in first school stage and 55.6 ± 29.4 and 65.8 ± 36.5 minutes in second school stage respectively. The prevalence of students meeting physical activity recommendations (a minimum of 60 minutes of daily MVPA) was 23.7%, while 17.4% of students did not meet the physical activity recommendation on any of the school days and 18.0% met the recommendation on one day. The students compliant and non-compliant with physical activity recommendations were similar in terms of BMI (U = 16054.5, p = 0.254) and proportion of under and normal weight students ($\chi^2(1) = 0.38$, p = 0.845) (table 2).

Table 2. The characteristics of students compliant and non-compliant with physical activity recommendations

	Compliant (n = 112)	Non-compliant (n = 360)
Gender (%)		
Boys	59.8	43.3*
Girls	40.2	56.7*
School stage (%)		
First school stage	65.2	48.9*
Second school stage	34.8	51.1*
Age (y)	9.00 ± 1.6	9.5 ± 1.7*
Height (cm)	140.3 ± 10.3	142.0 ± 12.2
Body mass (kg)	35.6 ± 8.9	38.3 ± 12.8
BMI	17.9 ± 2.8	18.6 ± 3.6
Weight status (%)		
Under and normal weight	70.5	71.5
Overweight and obese	29.5	28.5
Daily MVPA (min)	95.3 ± 31.2	55.6 ± 29.4*
Before-school MVPA (min)	8.5 ± 6.8	4.6 ± 4.1*
In-school MVPA (min)	19.9 ± 13.6	14.3 ± 11.2*
After-school MVPA (min)	68.8 ± 31.0	37.7 ± 26.1*

Data presented as mean ± standard deviation or %.
* – statistically significant difference between students compliant and non-compliant with physical activity recommendations, p<0.05.
MVPA – moderate to vigorous physical activity. BMI – body mass index.

Significantly more boys than girls were compliant with physical activity recommendations (χ^2 (1) = 9.32, p = 0.002). Within school stage, there was a trend that more boys are compliant with physical activity recommendations than girls (χ^2 (1) = 4.19, p = 0.051 and χ^2 (1) = 4.33, p = 0.050 in first and second school stage respectively) (figure 1).

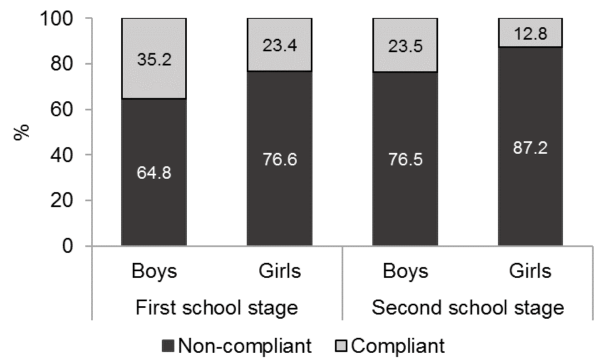

Figure 1. The proportion of students compliant and non-compliant with physical activity recommendations by gender and school stage.

On average in-school physical activity accounted for 21.8% (19.9 ± 13.6 minutes) of compliant and 27.2% (14.3 ± 11.2 minutes) of non-compliant students' total daily physical activity on school days. Only 3.2% of students acquired a minimum of 30 minutes of MVPA in school on three or more days, while the majority of students did not meet this in-school recommendation on any of the school days (figure 2).

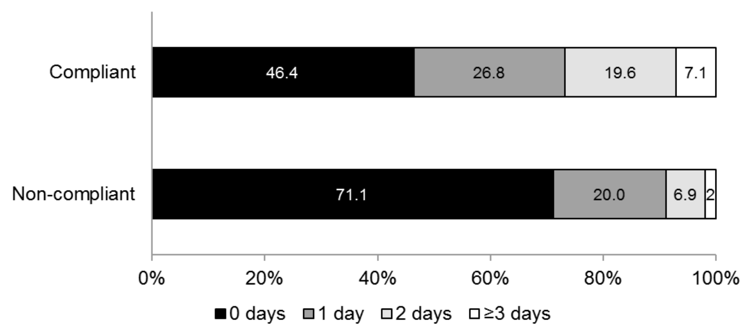

Figure 2. The distribution of students acquiring at least 30 minutes of moderate to vigorous physical activity during in-school time by the number of days.

Each additional MVPA minute in school was associated with a 1.1 (95% CI 1.0, 1.2) minute increase in daily MVPA. In each day segment the compliant students were more engaged in MVPA compared to non-compliant students (table 3). As for day segments, gender differences were only present in school, where girls acquired 4.5 (95% CI –5.5, –3.4) minutes less MVPA compared to boys. There were no gender differences in MVPA during before and after school segment, when controlled for school stage, BMI and compliance with physical activity recommendations. In school students compliant with physical activity recommendations were 4.3 (95% CI 3.1, 5.5) more minutes engaged in MVPA compared to non-compliant students.

Table 3. Multilevel analysis of moderate to vigorous physical activity in different school day segments

	Gender (Ref: Boys)	School stage (Ref: First school stage)	Compliance with PA recommendation (Ref: Non-compliant)
Day MVPA	–5.0 (–8.3, –1.7)*	–4.4 (–7.9, –0.9)*	33.6 (29.7, 37.5)*
Before-school MVPA	0.1 (–0.7, 0.8)	0.7 (–0.0, 1.5)	3.7 (2.9, 4.5)*
In-school MVPA	–4.5 (–5.5, –3.4)*	–0.5 (–1.7, 0.6)	4.3 (3.1, 5.5)*
After-school MVPA	–0.7 (–3.6, 2.2)	–2.5 (–5.7, 0.6)	25.6 (22.2, 29.1)*

Data are presented as beta coefficients (95% confidence interval). Models are controlled for BMI and time spent in segment.
* – statistically significant difference from reference group.
MVPA – moderate to vigorous physical activity.

4.2. Moderate to vigorous physical activity and sedentary behaviour in academic lessons

The characteristics of students included into the analysis of academic lessons is presented in table 4. Despite significantly different BMI in first and second school stage (U = 22 200, $p < 0.001$), the proportion of under and normal weight students was similar (χ^2 (1) = 0.55, p = 0.495).

Table 4. The characteristics of students by school stages

	First school stage (n = 305)	Second school stage (n = 258)
Gender (%)		
Boys	50.8	53.1
Girls	49.2	46.9
Age (y)	7.9 ± 0.7	11.0 ± 0.8*
Height (m)	1.34 ± 0.07	1.51 ± 0.09*
Body mass (kg)	32.0 ± 7.8	45.1 ± 12.5*
BMI (kg/m^2)	17.6 ± 2.9	19.6 ± 4.0*
Weight status (%)		
Under or normal weight	69.0	72.1
Overweight or obese	31.0	27.9

Data presented as mean ± standard deviation or %.
*– statistically significant difference between first and second school stage, $p < 0.05$.
BMI – body mass index.

Overall, the MVPA minutes were 1.1 minutes or below in all academic lessons in both school stages (table 5). Depending on the subject, the average sedentary time ranged from 32 to 36 minutes in first school stage and 33 to 39 minutes in second school stage.

Table 5. The general description of moderate to vigorous physical activity and sedentary behaviour by lesson and school stage

	First school stage	Second school stage
MVPA		
Native language	0.5 ± 0.8 (1.0%)	0.2 ± 0.4 (0.6%)
Mathematics	0.6 ± 1.1 (1.3%)	0.2 ± 0.5 (0.5%)
Science	1.1 ± 2.1 (2.4%)	0.2 ± 0.5 (0.5%)
Foreign language	0.7 ± 1.0 (1.5%)	0.3 ± 0.6 (0.7%)
Music	1.1 ± 1.4 (2.5%)	0.5 ± 0.7 (1.1%)
Crafts	0.7 ± 1.0 (1.6%)	0.7 ± 1.1 (1.6%)
Total	0.7 ± 1.2 (1.5%)	0.3 ± 0.6 (0.7%)
Sedentary time		
Native language	35.8 ± 5.9 (79.5%)	38.5 ± 4.5 (85.6%)
Mathematics	34.5 ± 7.5 (76.8%)	38.9 ± 4.7 (86.4%)
Science	32.1 ± 8.9 (71.4%)	38.2 ± 5.1 (85.0%)
Foreign language	33.1 ± 7.3 (73.6%)	37.4 ± 5.6 (83.2%)
Music	31.6 ± 7.2 (70.2%)	35.5 ± 6.1 (78.9%)
Crafts	32.6 ± 5.8 (72.5%)	32.9 ± 6.0 (73.1%)
Total	34.0 ± 7.0 (75.5%)	37.6 ± 5.4 (83.6%)
Sedentary bout length		
Native language	12.3 ± 9.6 (27.4%)	17.9 ± 13.1 (39.8%)
Mathematics	15.3 ± 10.9 (34.0%)	21.6 ± 14.0 (48.0%)
Science	14.1 ± 10.8 (31.3%)	20.3 ± 13.5 (45.2%)
Foreign language	14.3 ± 10.0 (31.7%)	18.2 ± 12.9 (40.5%)
Music	13.2 ± 8.8 (29.4%)	16.6 ± 11.6 (36.9%)
Crafts	6.9 ± 9.0 (21.2%)	9.0 ± 7.7 (19.9%)
Total	12.8 ± 9.7 (28.5%)	17.3 ± 13.1 (38.6%)

Data are presented as mean ± standard deviation (mean % from lesson time).
MVPA – moderate to vigorous physical activity.

In most subjects, except crafts, the proportion of lesson time MVPA was significantly lower and the proportion of sedentary time and average length of sedentary bout significantly higher in second compared to first school stage (table 6). The greatest difference in the proportion of lesson time MVPA between first and second school stage was present in science (–1.9, 95% CI –3.1, –0.6) and in music lessons (–1.2, 95% CI –2.1, –0.4). The difference in the proportion of sedentary time in second school stage was greatest in science (11.7, 95% CI 6.4, 17.0) and foreign language (10.0, 95% CI 6.2, 13.9) lessons compared to first school stage. There was 6.2 to 7.8-minute difference in the average sedentary bout length in most subjects, except crafts, in the second school stage compared to first school stage.

Table 6. The multilevel analysis of difference in moderate to vigorous physical activity and sedentary behaviour between first and second school stage by lesson

	Proportion of MVPA	Proportion of sedentary time	Sedentary bout length
Native language	–0.6 (–0.9, –0.2)*	6.0 (3.9, 8.1)*	7.5 (5.1, 10.0)*
Mathematics	–0.7 (–1.1, –0.2)*	8.5 (5.4, 11.6)*	7.8 (5.3, 10.2)*
Science	–1.9 (–3.1, –0.6)*	11.7 (6.4, 17.0)*	7.7 (4.3, 11.0)*
Foreign language	–0.9 (–1.7, –0.2)*	10.0 (6.2, 13.9)*	5.5 (1.4, 9.5)*
Music	–1.2 (–2.1, –0.4)*	9.0 (4.3, 12.8)*	6.2 (3.5, 8.9)*
Crafts	–0.1 (–1.1,1.0)	0.3 (–3.0, 3.5)	0.6 (–1.8, 2.9)

Data are presented as beta coefficients (95% confidence interval). Models are controlled for BMI and gender.
* – statistically significant difference from first school stage.
MVPA – moderate to vigorous physical activity.

4.3. Moderate to vigorous physical activity and sedentary time in physical education lesson and their contribution to overall physical activity

Students included into the analysis of physical education lessons are described in table 7. The proportion of under and normal weight students were similar in both school stages ($\chi^2(1) = 1.58$, $p = 0.215$) and 28.3% of students were classified as overweight or obese. In both school stages more than half of the students (52.3% and 61.3% in first and second school stages respectively) participated in organised sport at least once a week.

Table 7. The characteristics of the students by school stage

	First school stage (n = 266)	Second school stage (n = 238)
Gender (%)		
Boys	51.9	46.2
Girls	48.1	53.8
Age (y)	7.9 ± 0.6	10.9 ± 0.8*
Height (m)	1.33 ± 0.07	1.50 ± 0.09*
Body mass (kg)	31.7 ±7.7	44.5 ± 12.5*
BMI (kg/m^2)	17.6 ± 2.9	19.4 ± 4.0*

	First school stage (n = 266)	Second school stage (n = 238)
Weight status (%)		
Under or normal weight	69.2	74.5
Overweight or obese	30.8	25.5
Daily MVPA (min/day)	70.3 ± 34.4	60.6 ± 33.3*
Daily MVPA (%)	8.6 ± 4.0	7.4 ± 4.0*
Daily sedentary time (min/day)	447.5 ± 81.1	512.9 ± 89.5*
Daily sedentary time (%)	54.6 ± 8.1	62.6 ± 8.2*

Data presented as mean ± standard deviation or %.
*– statistically significant difference between first and second school stage, $p < 0.05$.
BMI – body mass index. MVPA – moderate to vigorous physical activity.

During physical education lesson students were engaged in MVPA on average 28.6 ± 16.5% (13.0 ± 9.3 minutes) and were sedentary 29.3 ± 19.8% (13.8 ± 19.8 minutes) of lesson time. Only 4.2% and 11.4% of students in the first and second school stage respectively achieved the recommended proportion (50%) of MVPA during physical education lesson.

In physical education lesson girls accrued 2.1 (95% CI –3.2, –1.0) less MVPA minutes and 1.9 (95% CI 0.7, 3.2) more sedentary minutes compared to boys (table 8). Students in the second school stage had more MVPA and less sedentary minutes during physical education lesson compared to first school stage. Time spent as sedentary and in MVPA was similar for students with different BMI. Each additional minute in MVPA in physical education lesson was associated with a 1.4-minute increase in daily MVPA.

Table 8. The multilevel analysis of moderate to vigorous physical activity in physical education lessons and on days with physical education

	PE MVPA (min)	PE sedentary (min)	Day MVPA (min)	Day sedentary (min)
Gender (Ref: Girls)	–2.1 (–3.2, –1.0)*	1.9 (0.7, 3.2)*	–6.5 (–11.1, –2.0)*	9.2 (–0.8, 19.1)
School stage (Ref: II school stage)	1.9 (0.7, 3.0)*	–2.7 (–4.0, –1.4)*	–10.7 (–15.5, –6.0)*	65.2 (54.7, 75.8)*
BMI	–0.2 (0.4, 0.0)	0.0 (–0.2, 0.2)	–0.8 (–1.4, –0.1)*	0.3 (–1.1, 1.8)
PE MVPA			1.4 (1.1, 1.6)*	
PE sedentary				1.4 (1.1, 1.8)*

Data are presented as beta coefficients (95% confidence interval). Models are controlled for BMI, gender, school stage, organised sport participation, time spent in physical education lesson.
* – statistically significant difference from reference.
PE – physical education lesson; BMI – body mass index; MVPA – moderate to vigorous physical activity.

The average MVPA minutes on days with and without physical education lesson are presented in figure 3. On days with physical education lesson students had 12.8 (95% CI 10.5, 15.0) minutes more MVPA and 9.7 (95% CI –16.3, –3.1) minutes less sedentary time compared to days without PE when controlled for organised sport participation after school.

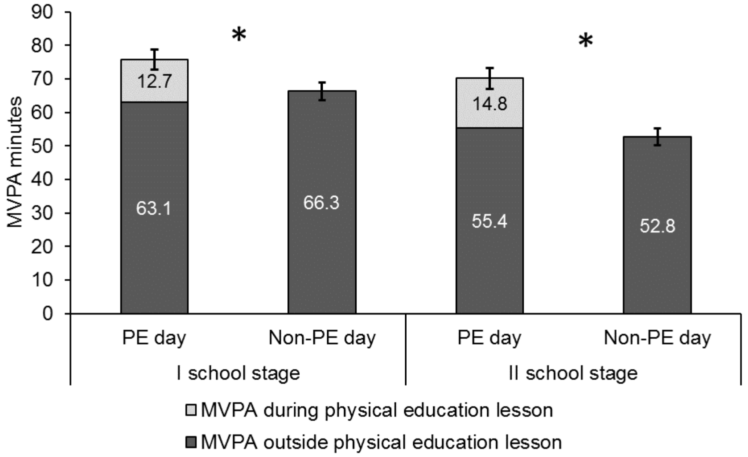

Figure 3. An average moderate to vigorous physical activity on days with and without physical education lesson in first and second school stage (mean and 95% CI). * – statistically significant difference between days with and without a physical education lesson according to multilevel analysis.

5. DISCUSSION

The purpose of the present study was to assess the objectively measured physical activity and sedentary behaviour in different lessons and the students' compliance with physical activity recommendations on school days. Firstly, we found that only quarter of students met the physical activity recommendations on school days, while more than third of students met the recommendation on one or none of the days. Secondly, in academic lessons the sedentary behaviour dominated. Moreover, the proportion of MVPA was lower and sedentary time higher in the second compared to first school stage. Thirdly, despite relatively low MVPA in physical education lessons, physical education contributed significantly to daily physical activity. The results of present study extend the current literature by giving a detailed information concerning physical activity and sedentary behaviour on school days and in different lessons. The finding of our study highlight the need to take actions in the school setting in order to combat the inactivity of students.

5.1. Overall physical activity on school days

Despite the favourable effects of physical activity on health [2,3], in current study only 24% of students met the physical activity recommendations on school days and more than a third of students met the recommendations on one or none of the days. According to previous studies using objective methods, the prevalence of children compliant with physical activity recommendation ranges from 20% in Spain to 87% in Norway [6]. It can be hypothesised that in weekly term, the actual prevalence of compliant students is even less than 24% found in current study, as students are more active on weekdays than on weekend days [83]. According to socio-ecologic model [47], physical activity is influenced by many social and environmental factors which can have supportive or hindering effect. Based on Estonian Physical Activity Report Card 2016, there is room for improvements in all fields investigated (participation in organised sport, active play, active transport, family and peers, school, community and environment, and government) [28]. Therefore, our results highlight the need to create and support the physical activity opportunities. Similarly to previous study [52], students compliant with physical activity recommendations were more engaged in MVPA in all day segments investigated compared to non-compliant students.

Considering the in-school time, it has been recommended that students should accumulate 30 minutes of MVPA at school [8], which is half of the daily recommendation for 5–17 year-old children [5]. In current study only 3% of students acquired 30 minutes of MVPA in school on three or more days and majority of students did not meet this recommendation on any of the school day. The prevalence of students meeting the in-school MVPA recommendation in our study was lower than previously reported a 7% average for five European countries [51] and was far from the proportions achieved with interventions. For example, several in-school interventions in USA incorporating physical activity to lessons and/or to recess have shown more than a third of students achieving the 30-minute recommendation in school [21,53]. It can be argued that the low physical activity levels of Estonian students in school can at some extent be explained by school rules which in many cases prohibit running and active play during recess. Although these rules are implemented mainly due to safety reasons, they hinder the physical activity of students. Moreover, despite the fact that the positive influence of outdoor play on health has been well documented [84], it is a common practice in Estonia that students are allowed outside only in good weather but otherwise are expected to remain indoors during recess. As the weather from late autumn to early spring tends to be rainy/snowy and cold, the students have few opportunities to spend recess outdoors. Also integrating physical activity to academic lessons, is not very frequent in Estonian schools. When looking at the contribution of in-school MVPA to daily physical activity, it can be concluded that schools have important input as 30–45% of daily MVPA can be acquired at school [9–11]. Although in current study the contribution of in-school MVPA was lower than previously reported, accounting for 22% of compliant and 27% of non-compliant students' total daily physical activity on school days, it is still a considerable input to overall levels of physical activity, especially for non-compliant students, as in the case of high-risk students even the modest amounts of physical activity can have tremendous health benefits [3]. Moreover, achieving half of the recommended daily physical activity at school, increases the odds of meeting daily recommendations three times [55]. Therefore, increasing in-school physical activity levels can considerably help students to achieve daily physical activity recommendations.

It is worth noting that in current study, contrary to "activitystat" hypothesis [73], in-school MVPA was positively associated with daily MVPA, indicating that students did not compensate active in-school time being less active after school, when controlled for BMI, gender and school stage. Similar association has also been reported in a study with 9–18 year-olds in USA [11] and 8–13 year-olds in Great Britain [85]. Moreover, when restricting physical activity opportunities in school, students do not engage in higher levels of physical activity after school [86], highlighting the need to offer physical activity opportunities during school hours. It has been stressed that whole school approach is an effective mean to increase the physical activity levels of students [48]. As classroom and school affiliation have significant influence on the physical activity behaviour of students, it is essential that the interventions focus on changing school (e.g. social norms, rules) [55].

In addition, our multilevel analysis confirmed previous findings that students in first school stage accumulated more MVPA minutes in school compared to second school stage [9,54] which is also in line with overall tendency that physical activity levels reduce with age [87,88] and indicate the need to take into account the age factor when designing and implementing interventions. Furthermore, similarly to earlier studies, girls were less active during school hours compared to boys [51,52,59], while there were no gender differences in after school physical activity [52]. It can be argued that the reason for in-school gender differences were due to boys preferring to participate in competitive games, while girls like to socialize with friends [89]. Another reason might be that girls may be more prone than boys to follow school rules that prohibit running, as it has been found that girls have higher self-discipline [90], however further research is needed. Nevertheless, our results highlight the need for gender-specific interventions in school setting. According to a recent meta-analysis, interventions aimed at increasing physical activity among girls showed greater effectiveness when they were educational, multicomponent, not based on certain theoretical frame and at the same time had high quality, targeted physical activity and diet together, lasted less than 12 weeks, and were with girls only [91].

In sum, the current study revealed that both overall and in-school physical activity levels are low and more effort should be made in supporting the physical activity of students throughout the school day.

5.2. Physical activity and sedentary behaviour in academic lessons

Class time has been identified as one important in-school segment which can support physical activity of students, especially those who are less physically active [12]. In current study low MVPA minutes in all academic lessons were observed, as MVPA accounted only for 0.5–2.5% of lesson time, which supports previous research from Ireland [57]. In addition, our multilevel analysis demonstrated a significantly lower proportion of lesson time MVPA in native language, mathematic, music, foreign language and science lessons in second school stage compared to first school stage. There was no difference between first and second school stage in the proportion of lesson time MVPA in crafts lesson, when controlled for BMI and gender. Our results contradict with previous findings where no decline in overall lesson-time MVPA was observed between age 10 and 14 [83] and therefore warrants further investigation. Nevertheless, several interventions have managed to increase lesson time MVPA considerably [58–61]. For example, it has been shown that classroom physical activity breaks are promising mean to increase lesson time physical activity and reduce sedentary time [21,22,57,92,93]. A recent interventions in math and native language lessons, where physical activity was integrated with lesson context, demonstrated that students spent as high as 24% (8 minutes) [57] to 60% (14 minutes) [60,61] of lesson time in MVPA. A research evidence suggests that activity breaks and active lessons have a great potential in supporting students' physical activity levels, as students who received activity breaks during lessons were 75% more likely to acquire 30 minutes of MVPA during school hours [65], thus making active lessons a promising mean in public health perspective. Not less important is the fact that students report enjoying activity breaks [57], since fun and enjoyment are identified as main motivators to participate in physical activity [94]. According to a recent review [95] main barriers the classroom teachers face when integrating physical activity to lessons are time constraints, the pressure to cover curriculum content and do academic testing, issues with class management, lack of encouragement from colleagues and administration, and perceived competence. It is highly likely that these barriers apply also to Estonian teachers. It has been pointed out that in order to increase lesson-time physical activity it is essential to support the professional development and preparation of teachers [96], so that teachers would be aware of different methods of integrating physical activity to lesson and would feel competent in using them.

One important issue emerging from our study was the high proportion of lesson time spent as sedentary, forming an average of 76% and 84% of lesson in first and second school stage respectively, which is higher than 64–71% reported by interventions aimed at integrating physical activity with lesson context [58,59]. These results suggest that in Estonian schools in general traditional teaching methods dominate where students are expected to sit still the whole lesson and physical activity is not integrated with lesson context. Previously it has been indicated that in older grades light physical activity in lessons is being replaced by sedentary behaviour [83]. In current study, the greatest increase in the proportion of sedentary time in second school stage was in science compared to first school stage. As sedentary time has been associated with health risks in children [36–39] and even light intensity physical activity has beneficial effect on the health of children [2], actions should be taken to reduce sedentary time in lessons.

Besides the proportion of sedentary time, according to multilevel analysis the sedentary bout length was longer in second school stage compared to first school stage in most subjects. More precisely, the difference in sedentary bout length ranged from 6–8 minutes depending on the subject, whereas craft was the only subject where proportion of MVPA, sedentary time and sedentary bout length was similar in first and second school stage. It could be argued that unfavourable changes in lesson time physical activity and sedentary behaviour were due to increasing academic demands in the second school stage. At the same time, lesson time physical activity has been associated with better on-task behaviour [19–22] and academic achievement [1,18,24,25]. Therefore, physical activity seems to be an unused resource during lessons which is a promising mean to support both academic achievement as well as the health of students. As time spent as sedentary is more dependent on the school than time spent in MVPA [97], the findings of our study present a great challenge to adjust the traditional educational system where physical activity and movement would be a normality, with special attention paid on older grades.

5.3. Physical activity and sedentary time in physical education lesson

Physical education lesson has indispensable role in providing physical activity and teaching fundamental movement skills necessary for lifelong physical activity. It has been recommended that students should be engaged in MVPA at least for an half of the physical education lesson [8]. According to reviews [67,68] and a meta-analysis [69] students are engaged in MVPA for 27–47% of physical education lesson, with observational method presenting higher values than objective methods [69]. The results of current study demonstrated that only a third of physical education lesson was spent in MVPA, which is line with a recent study with objectively measured physical activity [62,69]. Still, according to some studies MVPA during physical education lesson is as low as 13% [59,98]. At the same time, in current study only 8% of students achieved the recommended 50% of physical education lesson in MVPA, which is one and half times lower than found in Switzerland [62] and five times lower than in USA [70]. This discrepancy between current and previous studies can probably be attributed to methodological differences. For example in Switzerland [62] the sample consisted of several datasets where one of the data was an intervention with extra physical education lessons [99], whereas in USA the physical activity values were calculated based on energy cost, measured with an armband which can overestimate actual physical activity [70]. Moreover, difference in the aims of curriculum and teaching methods can also partly explain the disparity between studies.

In addition to relatively low MVPA, students in present study spent another third of physical education lesson as sedentary. Data concerning the sedentary time in physical education lesson is rather limited and only few have reported the proportion of sedentary time accounting for 16–23% of lesson time [64,70,71]. The results of our study suggest that there is a need to support and improve the quality of physical education lessons in order to reduce the sedentary time. According to previous studies, professional teacher training to improve lesson preparation and management could increase time in MVPA and substitute sedentary behaviour with light activity [100]. Effective interventions in physical education lessons, which included teacher professional learning focusing on class organisation, management and instruction, and adding high-intensity activity, have demonstrated 24% more active learning time compared to usual practice [101]. In addition, enabling adequate number of physical education teachers per students, appropriate equipment and facilities can have positive impact on physical activity levels during physical education lesson [102]. In 2008 the learning environment of physical education lesson was considered good or very good by 61% of Estonian physical education teachers, at the same time lack of equipment and sporting facilities were reported as the main barriers [103]. However, more recent data is needed for evaluating the current situation.

As for differences in gender and school stage, similarly to previous studies [62,70] our multilevel analysis demonstrated that boys acquired more MVPA minutes in physical education lesson compared to girls. Despite the overall tendency that both daily [87] and in-school [9,53–55] physical activity decreases and sedentary time increases with age, in current study the students from second school stage were more engaged in MVPA and less as sedentary during physical education lesson compared to students from first school stage. Similar trend that MVPA in physical education lesson is higher in older grades, has also been reported previously [67,68] and explained by enhanced motor development, perceived competence and access to a wider range of physical activities in older school stage [68]. Physical activity levels in physical education lesson can also be influenced by the educational level of teachers as specialist taught physical education lesson can increase time spent in MVPA [100,104]. In Estonia, it is a common practice that in first school stage physical education lessons are provided by class teacher and not by trained physical education teacher. Unfortunately, we do not have any data available to control for the possible effect of teacher training.

Another important finding emerging from present study was that despite relatively small proportion of MVPA and large proportion of sedentary time, physical education lesson had a significant contribution to daily physical activity as according to multilevel analysis, each additional MVPA minute in physical education lesson was associated with a 1.4-minute increase in daily MVPA. These results are in agreement with previous study conducted in USA where a 5-minute increase was recorded [70]. Therefore, our results did not support "activitystat" hypothesis and confirmed that students do not compensate higher physical activity during physical education by reducing activity levels in other day segments after school [12,62,64,70], and on contrary to this hypothesis, physical education lesson significantly contributed to daily physical activity.

When comparing days with and without physical education lesson, a significant impact of physical education was observed. According to multilevel analysis, on days with physical education lesson, students acquired 13 more minutes in MVPA compared to days without physical education when controlled for BMI, gender, school stage and organised sport participation. A contribution of physical education in similar magnitude (10–16 minutes) to overall MVPA has also been documented previously [62,63,70]. As for the sedentary time, there is no consensus on whether the amount of sedentary time on days with and without PE is different [62,64,70]. The results of current study support the beneficial influence of physical education lesson [62,64,105] as on days with physical education lesson students were 10 minutes less sedentary compared to days without physical education lesson. As sedentary behaviour tracks from childhood to adolescence and the tracking of sedentary behaviour is more consistent than tracking of physical activity [106], strategies to reduce sedentary time have the potential to gain sustained benefits that carry over to later life.

Overall, our findings highlight the importance of physical education lesson to the overall physical activity and support the position that physical education should be offered every school day. The positive influence of daily physical education lesson does not only increase daily MVPA, but also favourable changes in BMI [104,107], physical fitness [108] and academic performance [109] are present.

When interpreting the results, we have to consider that despite accelerometer ActiGraph used in current study has shown to be a valid device for measuring the physical activity of students [43], there are some activities that are not well detected. Thus, the physical activity levels could be underestimated. However, the presence of such activities is expected to be minimal in physical education and academic lessons. In addition, our results may be somewhat limited by not controlling for possible influence of season or weather conditions. According to previous studies, the daily physical activity of students can be influenced by seasonal variations, as children tend to be more physically active during spring/ summer months compared to autumn/winter months [110,111]. At the same time seasonal effect has shown to be stronger at the weekend than during the week [111] and no seasonal influence on physical activity levels has been observed during recess [112]. Therefore, whether and to what extent the physical activity of Estonian students is influenced by weather, warrants further investigation.

6. CONCLUSIONS

1. A quarter (23.7%) of 7–13 yea-old Estonian students met the physical activity recommendations on every school day, whereas more than third (35%) of students met the recommendations on one or none of the days. Student compliant with physical activity recommendations acquired more MVPA minutes in all day segments compared to non-compliant students.
2. In all academic lessons, the sedentary time dominated and the levels of moderate to vigorous physical activity during lessons remained below 1.2 minutes in all lessons. Moreover, in second school stage the proportion of sedentary time was higher, average sedentary bout length longer and moderate to vigorous physical activity lower compared to first school stage in native language, mathematics, music, science and foreign language lessons.
3. In physical education lesson, students from second school stage and boys were more engaged in moderate to vigorous physical activity and had less sedentary time compared to first school stage and girls, respectively.
4. Physical education lesson had an important contribution to daily physical activity levels, and on days with physical education lesson, students acquired more minutes of moderate to vigorous physical activity and were less sedentary compared to days without physical education lesson.

7. PRACTICAL IMPLICATIONS

The current cross-sectional study demonstrated that both the daily and in-school levels of MVPA are low in Estonian schools, thus highlighting the need for school-based intervention. As sedentary time and low levels of MVPA are independent health risk factors, school-based interventions should have two aims 1) to increase moderate to vigorous physical activity so that students acquire a minimum of 30 minutes of MVPA during school hours, 2) to reduce sedentary time, especially prolonged sitting. There is a need to support schools, provide an evidence-based solution and rise confidence in creating opportunities for physical activity in school. Our results suggest that the academic lessons in Estonia are an unused resource for acquiring physical activity and reducing sedentary time in school setting, as sedentary behaviour dominated in both school stages. Therefore, special attention should be paid on supporting the teachers in implementing activity breaks during academic lessons or integrating physical activity with lesson content. Moreover, our results highlighted the need for gender-specific intervention, as in-school was the only day segment where girls were less active than boys. One promising mean in providing physical activity opportunities in school setting is the physical education lesson, which had significant contribution to daily MVPA and therefore adding extra physical education lessons to curriculum or alternative lessons where students can play and be physically active or participate in sport should be considered.

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SUMMARY IN ESTONIAN

Eesti 7–13 aastaste õpilaste liikumisaktiivsus ja kehaliselt mitteaktiivne aeg erinevates koolipäeva osades ja vastavus liikumisaktiivsuse soovitustele

Liikumisaktiivsuse positiivne mõju laste ja noorte tervisele ja heaolule on leidnud korduvalt kinnitust [2]. Lisaks on üha enam uuringuid, mis viitavad, et kehaliselt mitteaktiivne aeg on iseseisev terviserisk [4]. Tervisliku arengu tagamiseks peaksid lapsed ja noored vanuses 5–17 aastat liikuma iga päev mõõduka kuni tugeva intensiivsusega vähemalt 60 minutit [5]. Samas näitavad uuringud, et laste ja noorte liikumisaktiivsus Euroopas, sh Eestis, on madal [6]. Lähtudes üle-eestilisest küsitlusuuringust täidab Eesti 11–15 aastastest õpilastest liikumisaktiivsuse soovituse vaid 16% [44]. Laste ja noorte liikumisaktiivsuse toetamisel on olulisel kohal multisektoraalne koostöö [7] ning üht võtmerolli omab kool [8], kuna lapsed veedavad suure osa päevast koolis ning kooli keskkonnas on võimalik jõuda erineva sotsiaalmajandusliku taustaga õpilasteni. Varasemalt on välja toodud, et kehalise kasvatuse tunnil ja ainetundidel on kõige suurem potentsiaal toetada õpilaste, eriti väheaktiivsete õpilaste, liikumisaktiivsust koolikeskkonnas [12]. Samas puuduvad Eestis andmed objektiivselt mõõdetud liikumisaktiivsuse ja kehaliselt mitteaktiivse aja kohta koolipäevadel ning koolipäeva erinevates osades, mis annaksid ülevaate olukorrast ning võimalikust sekkumise vajalikkusest ja suundadest.

Käesoleva töö eesmärk oli selgitada 7–13 aastaste õpilaste liikumisaktiivsuse taset ja kehaliselt mitteaktiivse aja osakaalu erinevates ainetundides ning õpilaste liikumisaktiivsuse taseme vastavust liikumisaktiivsuse soovitustele. Alaeesmärkideks oli:

1. Selgitada liikumisaktiivsuse soovitusi täitvate õpilaste osakaal koolipäevadel ning võrrelda liikumisaktiivsuse soovitusi täitvate ja mittetäitvaid õpilaste mõõduka kuni tugeva intensiivsusega liikumisaktiivsust koolis.
2. Võrrelda I ja II kooliastme õpilaste mõõduka kuni tugeva intensiivsusega liikumisaktiivsuse ja kehaliselt mitteaktiivse aja osakaalu akadeemilistes tundides.
3. Võrrelda soolisi ja kooliastme erinevusi mõõduka kuni tugeva intensiivsusega liikumisaktiivsuses ja kehaliselt mitteaktiivses ajas kehalise kasvatuse tundides.
4. Selgitada kehalise kasvatuse tunni panus õpilaste päevasesse mõõduka kuni tugeva intensiivsusega liikumisaktiivsusesse ja kehaliselt mitteaktiivsesse aega.

Uuringus osales 13 kooli üle Eesti, mis valiti juhuväljavõttega Haridus- ja Teadusministeeriumist saadud Eesti keelt kõnelevate koolide nimekirjast ning lähtudes kriteeriumist, et samast maakonnast ei valita üle kahe kooli. Kõik uuringus osalenud koolid, lapsevanemad ja õpilased (n = 819) andsid kirjaliku nõusoleku uuringus osalemiseks. Kõikidest nõusoleku andnud õpilastest moodustati alavalim liikumisaktiivsuse mõõtmiseks. Uuringus osalesid 1. –2. (I kooliaste, n = 352) ja 4.–5. klassi (II kooliaste, n = 284) õpilased. Liikumisaktiivsuse mõõtmises osalenud õpilased kandsid ühe koolinädala aktseleromeetrit Actigraph GT3x-BT (ActiGraph LLC, Penascola, FL, USA), mis salvestas andmed 15-sekundilise intervalliga. Lisaks täitsid õpilased liikumisaktiivsuse päevikut, kuhu märkisid koolis viibitud aja ning kehalise kasvatuse tunnis ja organiseeritud spordis osalemise aja. Erinevate ainetundide toimumise ajad saadi kooli tunniplaanist. Lisaks mõõdeti esimesel mõõtmispäeval koolis õpilaste mass ja pikkus ning arvutati kehamassiindeks. Liikumisaktiivsuse andmete töötlemisel kasutati Evensoni lõikepunkte [43]. Liikumisaktiivsuse soovituse täitjate ja mittetäitjate väljaselgitamisele ja võrdlemisele suunatud analüüsi kaasati õpilased, kellel oli vähemalt 10h liikumisaktiivsuse andmeid vähemalt neljal päeval (n = 472). Akadeemiliste ainetundide analüüsis kasutati õpilaste andmeid, kellel oli vähemalt ühel päeval vähemalt 4h andmed (n = 563). Antud uuringus loeti akadeemilisteks aineteks eesti keel, matemaatika, võõrkeel, loodusõpetus, muusika ja tehnoloogiaõpetus/joonistamine. Selgitamaks liikumisaktiivsust kehalise kasvatuse tunnis ning kehalise kasvatuse tunni rolli päevases liikumisaktiivsuses oli analüüsi kaasamise kriteeriumideks vähemalt 10h liikumisaktiivsuse andmete olemasolu vähemalt kolmel koolipäeval (n = 504). Andmeanalüüsis kasutati lineaarseid segamudeleid, mis võimaldasid arvesse võtta iga mõõtmispäeva andmeid.

Vastavalt töö tulemustele tehti järgmised järeldused:

1. Ligikaudu veerand (24%) õpilastest täitis kõikidel koolipäevadel liikumisaktiivsuse soovitusi, samas üle kolmandiku (35%) õpilastest liikus vastavalt liikumissoovitustele ainult ühel või mitte ühelgi päeval. Liikumisaktiivsuse soovitusi täitnud õpilased olid enam mõõduka ja tugeva intensiivsusega kehaliselt aktiivsed nii enne kooli, koolis, kui ka peale kooli.
2. Kõikides akadeemilistes ainetes domineeris kehaliselt mitteaktiivne aeg ning mõõduka kuni tugeva intensiivsusega liikumisaktiivsus jäi alla 1,2 minuti. Lisaks oli II kooliastmes suurem kehaliselt mitteaktiivse aja osakaal, pikem järjestikkuse istumise keskmine aeg ning väiksem mõõduka kuni tugeva liikumisaktiivsuse osakaal võrreldes I kooliastmega.
3. Kehalise kasvatuse tunnis olid II kooliastme õpilased ning poisid enam mõõduka kuni tugeva intensiivsusega kehaliselt aktiivsed ning vähem kehaliselt mitteaktiivsed võrreldes vastavalt I kooliastme õpilastega ja tüdrukutega.
4. Kehalise kasvatuse tund lisas oluliselt mõõduka kuni tugeva intensiivsusega liikumisaktiivsuse minuteid kogu päevasesse liikumisaktiivsusesse. Päevadel, kui õpilased osalesid kehalise kasvatuse tunnis, oldi oluliselt rohkem mõõduka kuni tugeva intensiivsusega kehaliselt aktiivsed ning oluliselt vähem kehaliselt mitteaktiivsed võrreldes päevadega, mil kehalise kasvatuse tunnis ei osaletud.

Käesoleva töö tulemused andsid ülevaate 7–13 aastaste Eesti õpilaste liikumisaktiivsusest koolipäeval ning viitavad vajadusele läbi viia sekkumisi, mis toetaksid koole liikumisaktiivsuse võimaluste loomisel.

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2015–	Tartu Ülikooli liikumislabori peaspetsialist
2013	Glasgow Ülikool, teadur
2008–2015	Tervise Arengu Instituut, projektijuht
2007	Ida Euroopa Sotsiaaluuringute Keskus.

Peamised uurimisvaldkonnad:
Laste, noorte, täiskasvanute ja sportlaste liikumisaktiivsus; sportlik saavutusvõime; geneetika; anti-doping.

Publikatsioonid:
Artiklid rahvusvahelistes eelretsenseeritud ajakirjades – 10
Artiklid muudes teadusajakirjades – 2
Konverentside teesid – 17

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